# GFAC update for the IGC Plenary Agenda

dated 8 February 2022

References

A: Plenary Agenda 6_1_3_2022_y2_sc3_2_4_6_den_fra - remove_periodic_calibration_of_flight_recorders.pdf

B: Plenary Agenda 7_2_5_2022_gfac_report.pdf

C: Current IGC-approved Flight Recorders, via www.fai.org/igc-documents

1. Reference A is the Year 2 proposal from Denmark and France for the removal of periodic calibrations. This has now been analysed by GFAC and continues to be opposed in a similar way to the Year 1 proposal to the 2021 Plenary, as initially covered in Reference B. Detailed criticism of Reference A follows in paragraph 2 and its wide impact is shown in Reference C, which lists 61 different types of IGC-approved Flight Recorder from 21 manufacturers. Annex A to this document contains references to Pressure Sensor drift in recording devices, contrary to claims in Reference A. Also contrary to Reference A statements is Annex B to this document that includes a summary of actual Pressure Altitude errors in IGC Flight Recorders from a Technical Advisor to GFAC who is also a current Pressure Altitude calibrator.

2. In addition to the issues raised in the January GFAC report (Reference B), the Year 2 Denmark/France proposal (Reference A) contains the following wording (between "" symbols) that is not agreed, for the reasons stated below.

2.1. "They do not drift under time".
With over 60 different types of IGC-approved FR it is simply not possible to support such a statement. Most mechanical and electronic devices have outputs that drift with time unless there are specific systems or programs to prevent it. Pressure sensors in IGC Flight Recorders are low-cost (prices generally less than 3 Euros) and there is evidence that in many cases their output drifts with time. See the Annexes for positive evidence about Pressure Altitude drift.

2.2 "A less than 5-year old calibration certificate is now required even for simple badges".
This is incorrect because Sporting Code Section 3, para 2.4.3c says: "If the FR calibration period has lapsed, GPS height data may be used for Silver and Gold claims, provided that a 100 meter error margin is applied to all pressure height requirements of the Code (example: the gain of height is at least 1100 meters for Silver altitude)".

2.3. "Manufacturers having a long-term experience report that the pressure sensors don't drift".
Although some manufacturers may carry out post-sale calibrations, many NAC-approved Pressure Altitude calibrators also exist, and the above statement about "drift" is not correct, as shown by the figures in the Annexes.

2.4. "OOs and competition directors can check that the altitude sensor of the FR is fine by comparing the pressure altitude records by the GPS altitude records".
GPS altitudes in IGC files are with respect to the WGS84 Ellipsoid. This does not change with time, and because of the geometry of GPS position lines, GPS altitude errors are about twice those for Lat/Long. In contrast, atmospheric pressure and its variation with altitude changes constantly and depends on many meteorological factors. Therefore, accurate pressures at a glider in flight require a calibrated pressure sensor, not approximate estimates based on GPS altitudes.

2.5. "The uncertainty in pressure altitude for a typical Flight Recorder is about 6m at an altitude of 6000m".
This is simply not true - actual calibrations show substantially higher figures (See Annex B). In addition, for IGC rules and procedures, all types of IGC-approved FRs must be taken into account, not just a "Typical FR".

2.6. "The data in the calibration certificates are rarely used even in a WGC".
Accurate Pressure Altitude data is required to check compliance with airspace rules and to determine accurate penalties if prohibited airspace is approached or entered. Otherwise, a pilot who has entered prohibited airspace could win an IGC competition but at the same time could be prosecuted for airspace violation. Many IGC organisations currently enforce accurate air space rules. Examples include World Championships under SC3A rules, and UK National and Regional Competitions, where Calibration Certificates with a valid date are required, and are used to determine airspace penalties.

2.7 The consequences of implementing the Proposal could be that legitimate claims (particularly for Diamond height) could be rejected, because Annex B shows that several types of FR have errors that are greater at higher altitudes. It is also possible that airspace penalties (which are severe in IGC-sanctioned competitions) could be incorrectly applied.

3. In sum, the only way to record the accurate pressure altitude of a glider in flight, is to use an IGC-approved Flight Recorder that includes a pressure altitude sensor that complies with the current IGC rules on Calibration. The Denmark/France proposal therefore continues to be opposed.

Ian Strachan
Chairman IGC GNSS Flight Recorder Committee

Annex A - References to Pressure Sensor drift (Page 2)
Annex B - A current Calibrator's Report on Pressure Altitudes (Pages 3-6)

## References to Pressure Sensor drift

1. Reference 1: The web site of the Solinst Company of Ontario, Canada, includes the following words that re-inforce the need for periodic Calibrations:

"All pressure transducers - no matter what they are made of, how expensive they are, or how accurate - are susceptible to sensor drift over time. Pressure sensor drift is a gradual degradation of the sensor and other components that can make readings offset from the original calibrated state."

The precise reference follows:
www.solinst.com/products/dataloggers-and-telemetry/3001-levelogger-series/technical-bulletins/understanding-pressure-sensor-drift.pdf

2. Reference 2: www.stssensors.com/blog/2020/06/30/the-long-term-stability-of-pressure-sensors
This includes the following words on Pressure Sensors that re-inforce the need for periodic Calibrations:

"Despite all care, long-term stability and accuracy is physically impossible."

*and*

"The laws of physics place certain limits on a sensor's long-term stability."

*also*

"Factors such as pressure and temperature hysteresis cannot be completely eliminated."
*Note: A definition of Hysteresis is: "where the recorded value of a physical property lags behind changes in the actual value of the property".*

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## IGC Flight Recorders – To Calibrate or Not to Calibrate

I have been a BGA authorised FR calibrator for the last 40 years. During the 80s and the 90s clockwork barographs were still in use but from the turn of the century electronic flight recorders became the recorder of choice. Since then, I have calibrated more than 2500 units, archiving the IGC file and the corresponding calibration certificate. I have some calibrations of early legacy recorders such as the DX50, LX5000 and Cambridge GPS25 units that show excessive errors of many hundreds of feet at higher altitudes.

I have recent calibration records of some 200 units such as the LX8000, LX9000, Nano, Colibri II, Flarm and EOS. A number of recent LXNAV and LX Navigation products show calibrations outside IGC limits. The calibration charts of four units are attached.

I have calibrated around 150 LXNAV and LX Navigation FRs and these show about a 3% failure rate. Since world sales are estimated to be at least 10 times this figure, expanding to all units indicates that there may be quite a few out there with calibrations outside IGC specification limits. For example, 30 LX Navigation LX7007 units were calibrated between 2019 and 2021 and 10% of those tested (all in 2021) had errors that are listed below.

| FR Serial 9J2 18 Nov 21 | FR Q8U 28 Mar 21 | FR QJA 23 Jun 21 |
|---|---|---|
| +27m @ 0 ft | +19m @ 0 ft | +11m @ 0 ft |
| +41m @ 10k ft | +30m @ 10k ft | +18m @ 10k ft |
| +69m @ 20k ft | +53m @ 20k ft | +38m @ 20k ft |
| +85m @ 30k ft | +75m @ 30k ft | +55m @ 30k ft |

Since these FRs will have been calibrated on leaving the factory and adjusted to reduce the errors, the above figures show that reliance on an initial manufacturer's calibration with no periodic re-calibration, is not acceptable.

I do not usually get to see the manufacturer's original calibration chart. A recent exception was an LX Navigation EOS which performed satisfactorily until the owner upgraded the operating system (firmware), when he noticed on the ground that the 1013 datum height was now 4 hPa in error. This unit was given to me for calibration with the original manufacturer's calibration chart and I confirmed the error. A week later the owner flew a diamond height with this FR and the corrected heights from my calibration chart were compared with a calibrated Flarm FR that was carried on the same flight. The analysis on page 5 "Calculations for a Diamond Height Claim"shows very close agreement of gain-of-height from these two FRs. This confirms that my recent calibration of the EOS is correct and this FR experienced pressure altitude drift since its original manufacturer's calibration.

Both LXNAV and LX Navigation only calibrate to an altitude of 8km. If my calibrations are extended beyond this height, then the calibration errors of all units are invariably outside IGC specs above 8 km. This leads me to believe that the manufacturer calibrates each instrument by programming an offset to correct the heights or uses a "look-up table". It would appear that sometimes when the OS is upgraded, this offset or look-up table has been deleted.

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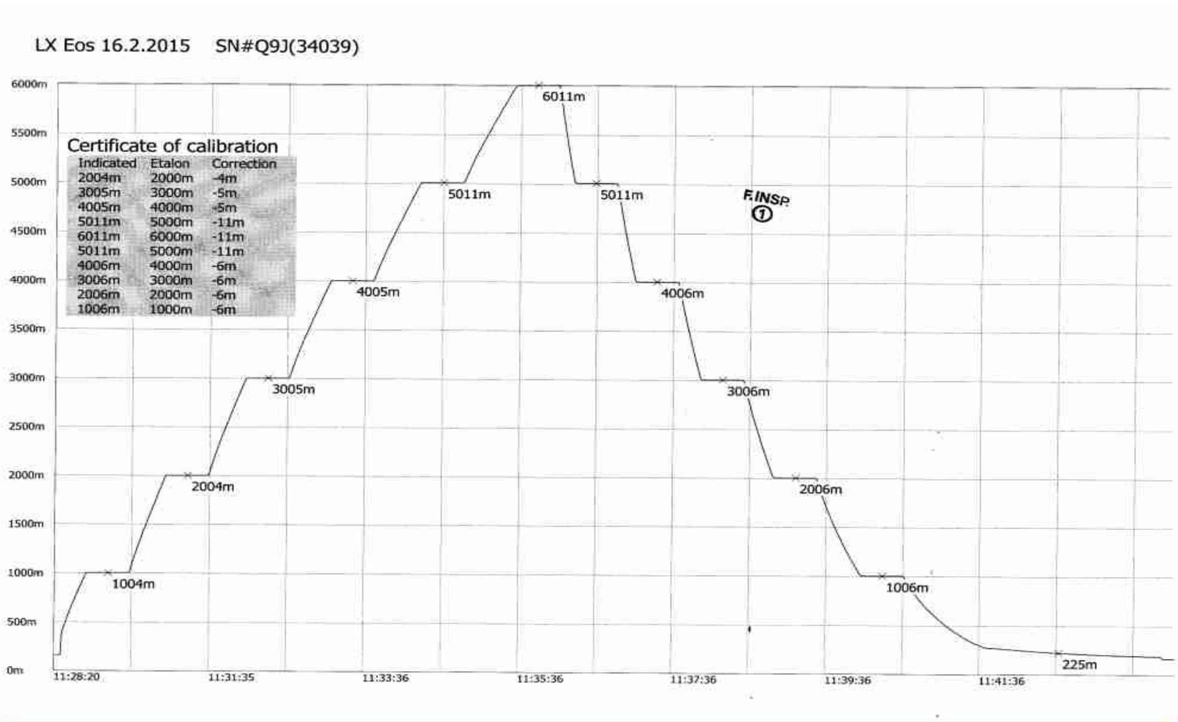
Attached: LX EOS Q9J height graph
LX EOS Q9J Calibration table
LXNAV LX 9000 7GH Calibration table
LXNAV NANO 2YK Calibration table
LXNAV NANO 2MD Calibration table
LX EOS Q9J Diamond Height figures





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## CALIBRATION CHART FOR LX EOS S/No Q9J

EOS calibrated on 18 November 2021 against LXNAV V3 electronic transducer altimeter S/No 00002 which has been calibrated against an Etalon sub standard in accordance with the FAI Sporting Code, Section 3, Annex C, Appendix 8. QFE = 1021.7 HPa. T = 15°C. As this is a FAI/IGC approved flight recorder, the .IGC calibration file is held on record at this facility.

| **Manometer** (In ft ref to 1013.2mbs) | **EOS Reads** (ft) | **Correction** (ft) |
|---|---|---|
| 0 | -90 | +90 |
| 1000 | 900 | +100 |
| 2000 | 1900 | +100 |
| 3000 | 2890 | +110 |
| 4000 | 3885 | +115 |
| 5000 | 4885 | +115 |
| 6000 | 5880 | +120 |
| 8000 | 7870 | +130 |
| 10000 | 9865 | +135 |
| 12000 | 11850 | +150 |
| 14000 | 13835 | +165 |
| 16000 | 15820 | +180 |
| 18000 | 17800 | +200 |
| 20000 | 19775 | +225 |
| 22000 | 21755 | +245 |
| 24000 | 23760 | +240 |
| 26000 | 25740 | +260 |
| 28000 | 27720 | +280 |

R Feakes 18 November 2021
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**CALIBRATION CHART FOR LX9000 S/No 7GH**

LX9000 calibrated on 26 January 2019 against LXNAV V3 electronic transducer altimeter S/No 00002 which has been calibrated against an Etalon sub standard in accordance with the FAI Sporting Code, Section 3, Annex C, Appendix 8. QFE = 981.0 HPa. T = 16°C. As this is a FAI/IGC approved flight recorder, the .IGC calibration file is held on record at this facility.

| Manometer (In ft ref to 1013.2mbs) | LX8000 Reads (ft) | Correction (ft) |
|---|---|---|
| 0 | -110 | +110 |
| 1000 | 890 | +110 |
| 2000 | 1895 | +105 |
| 3000 | 2885 | +115 |
| 4000 | 3885 | +115 |
| 5000 | 4880 | +120 |
| 6000 | 5885 | +115 |
| 8000 | 7885 | +115 |
| 10000 | 9860 | +140 |
| 12000 | 11830 | +170 |
| 14000 | 13815 | +185 |
| 16000 | 15815 | +185 |
| 18000 | 17800 | +200 |
| 20000 | 19785 | +215 |
| 22000 | 21760 | +240 |
| 24000 | 23760 | +240 |
| 26000 | 25730 | +270 |
| 28000 | 27690 | +310 |
| 30000 | 29720 | +280 |

R Feakes 26 January 2019
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**CALIBRATION CHART FOR NANO$^3$ S/No 2YK**

Nano$^3$ calibrated on 22 October 2019 against LXNAV V3 electronic transducer altimeter S/No 00002 which has been calibrated against an Etalon sub standard in accordance with the FAI Sporting Code, Section 3, Annex C, Appendix 8. QFE = 1013.2 HPa. T = 16°C. As this is a FAI/IGC approved flight recorder, the .IGC calibration file is held on record at this facility.

| Manometer (In ft ref to 1013.2mbs) | Nano$^3$ Reads (ft) | Correction (ft) |
|---|---|---|
| 0 | -70 | +70 |
| 1000 | 935 | +65 |
| 2000 | 1940 | +60 |
| 3000 | 2935 | +65 |
| 4000 | 3935 | +65 |
| 5000 | 4920 | +80 |
| 6000 | 5935 | +65 |
| 8000 | 7925 | +75 |
| 10000 | 9920 | +80 |
| 12000 | 11895 | +105 |
| 14000 | 13890 | +110 |
| 16000 | 15885 | +115 |
| 18000 | 17875 | +125 |
| 20000 | 19870 | +130 |
| 22000 | 21850 | +150 |
| 24000 | 23845 | +155 |
| 26000 | 25830 | +170 |
| 28000 | 27795 | +205 |
| 30000 | 29745 | +255 |

R Feakes 22 October 2019
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**CALIBRATION CHART FOR NANO S/No 1MD**

Nano calibrated on 8 August 2021 against LXNAV V3 electronic transducer altimeter S/No 00002 which has been calibrated against an Etalon sub standard in accordance with the FAI Sporting Code, Section 3, Annex C, Appendix 8. QFE = 998.5 HPa. T = 20°C. As this is a FAI/IGC approved flight recorder, the .IGC calibration file is held on record at this facility.

| Manometer (In ft ref to 1013.2mbs) | Nano Reads (ft) | Correction (ft) |
|---|---|---|
| 0 | -40 | +40 |
| 1000 | 950 | +50 |
| 2000 | 1945 | +55 |
| 3000 | 2940 | +60 |
| 4000 | 3940 | +60 |
| 5000 | 4925 | +75 |
| 6000 | 5930 | +70 |
| 8000 | 7915 | +85 |
| 10000 | 9905 | +95 |
| 12000 | 11880 | +120 |
| 14000 | 13870 | +130 |
| 16000 | 15865 | +135 |
| 18000 | 17850 | +150 |
| 20000 | 19835 | +165 |
| 22000 | 21805 | +195 |
| 24000 | 23805 | +195 |
| 26000 | 25780 | +220 |
| 28000 | 27740 | +260 |
| 30000 | 29750 | +250 |

R Feakes 8 August 2021
BGA Authorised Calibrator for the UK National Aero Club

## Calculations for a diamond height claim

Comparison of EOS and Flarm FRs carried in the glider

Takeoff: Aboyne Gliding Site, UK, height 548 ft ASL

**EOS FR Serial Q9J**
Calibration: Feakes, correcting original Maker's Calibration some years before
Low 2868 ft (+110 calibration)
High 21428 ft (+240 calibration)
Gain 18560 ft (+130 net calibration) = 18690 ft

**Flarm FR**
Low 2871 ft (-10 calibration)
High 21559 ft (-5 calibration)
Gain 18688 ft (+5 net calibration) = 18692 ft

**Conclusion**: After the Feakes EOS calibration, Gain-of-height figures from the two FRs are only 2 ft different, indicating the accuracy of the Feakes calibration. It also indicates drift compared to the earlier Manufacturer's calibration in which the correction figures would have been lower (similar to the Flarm), but are now out-of-date.